TRISHNA Cal/Val activities: preparatory studies

- ***Origin of TRISHNA Cal/Val activities***
- ***Overview of recent studies***
- ***Ongoing and Future studies***
- ***Multi-mission goals***

Presented by Mark IRVINE

INRAe, UMR 1391 ISPA FRANCE

*The **origins** of Cal/Val TRISHNA is related to the **quantification** of errors in surface temperature in the different domains of application*

- *Such as: Directional effects, Turbulence, Emissivity, Land use, Topography…*

Sites chosen in the framework of LST applications

- *Ecosystem stress, Urban climate, Coastal and inland waters, Cryosphere, Solid earth*

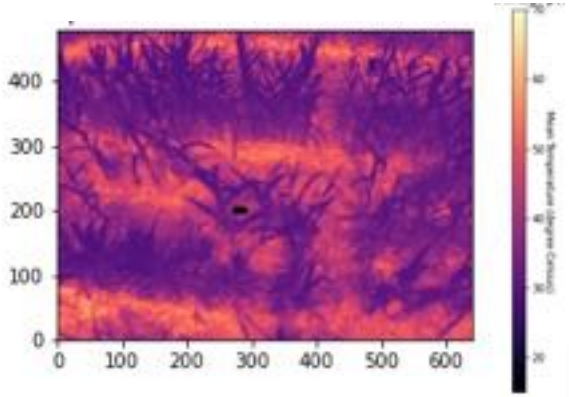
*Drawing on **Thematic** "validation" sites*

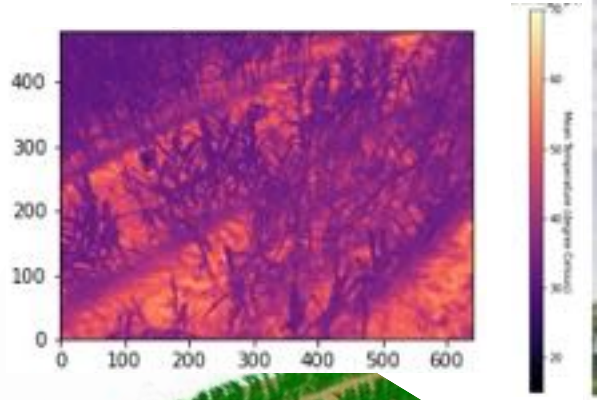
Promote** the use of **standardized instruments** and **protocols** with **traceable procedures

Some recent Cal/Val activities

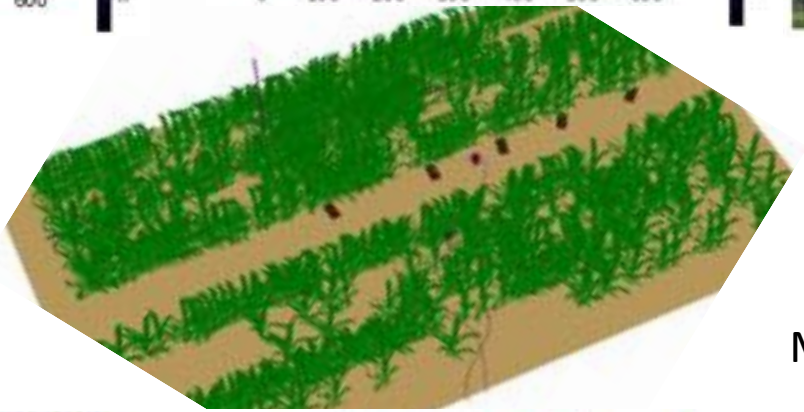
TRISHNA Cal/Val Overview – Recent work – directional effects

Test site Auzeville Toulouse





DART

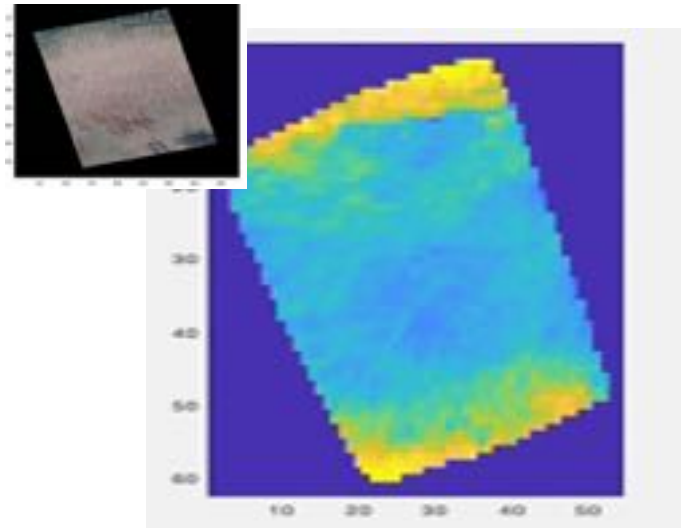


Multispectral B G R RE NIR
+ **TIR 8-14µm**

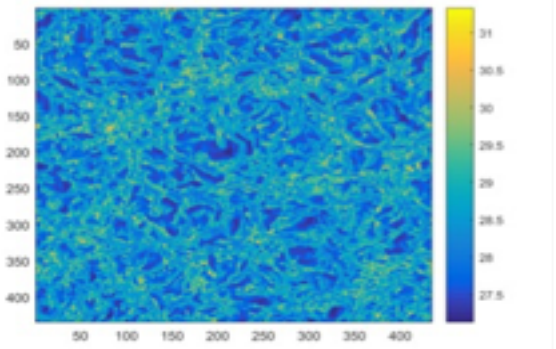
Improve directional parametrization

Poster 180

TRISHNA Cal/Val Overview – Recent work - turbulence

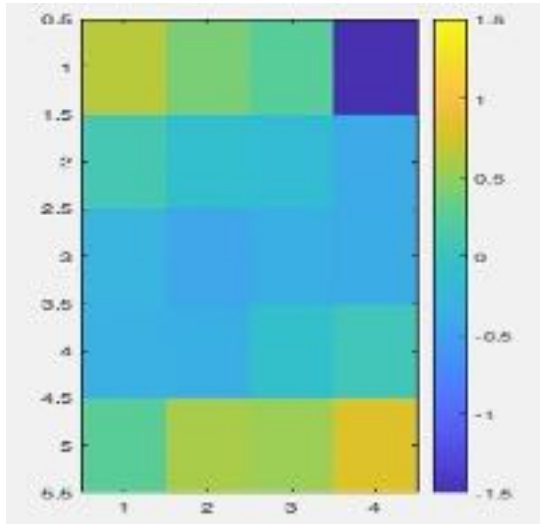


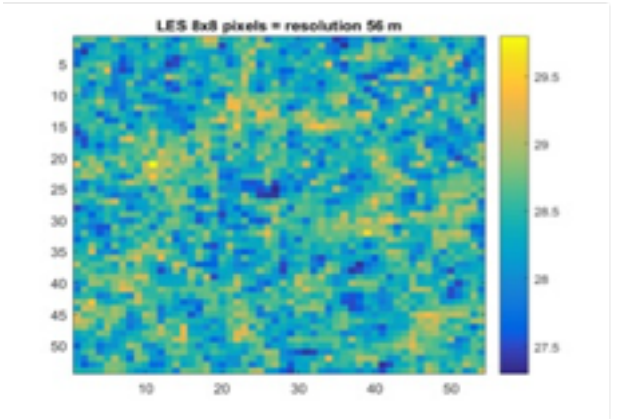
Observed LST using UAV 1x1m



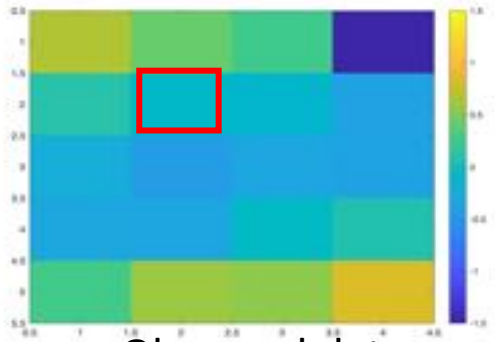
Simulated LST using LES 2x2m

degraded

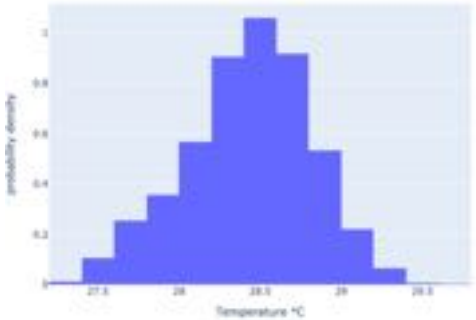




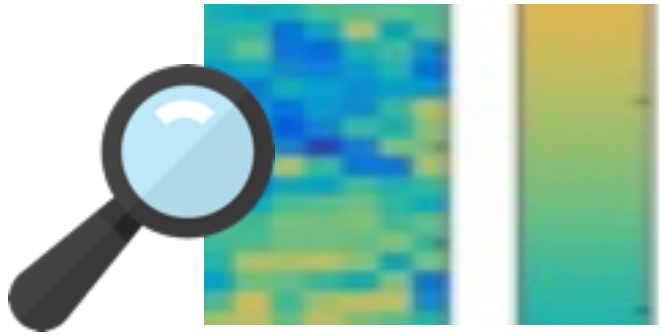
TRISHNA 60x60m Pixels



Observed data



±1°K variation



LES simulation

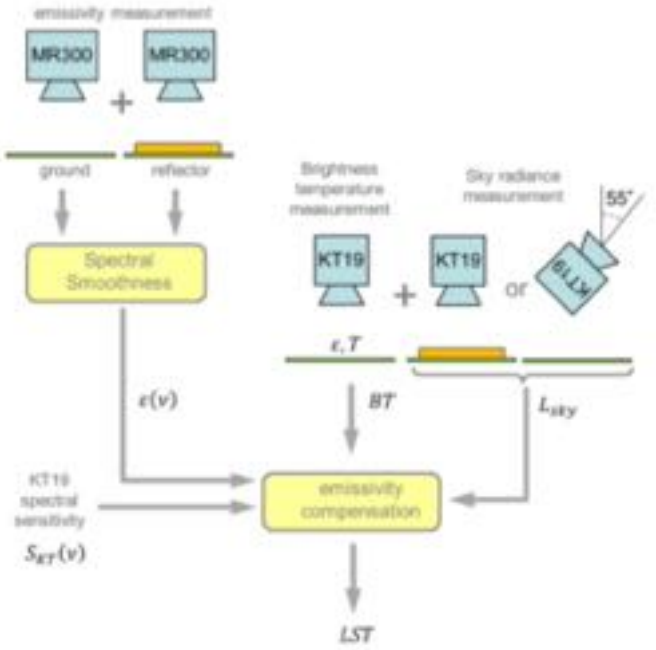
”Noise” due to boundary layer scale turbulence

Aim: quantification of underlying noise

Improve *in-situ* estimates by adapting protocols

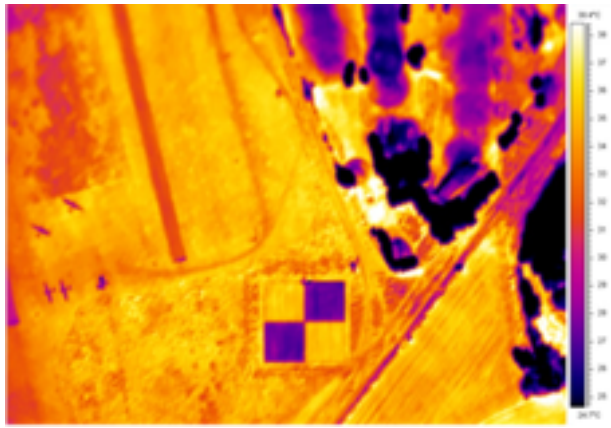
TRISHNA Cal/Val Overview – Recent work - emissivity

Problem: successful LST retrieval depends on emissivity



Measurement schematic

In-field measurements



Simultaneous
In-situ, UAV and Aircraft observations

Approach:
Transposable laboratory spectral measurements towards in field characterisation

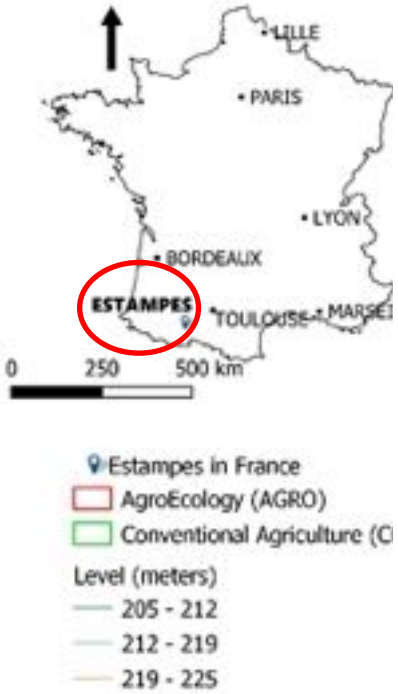
Comparison with multi-band estimates

TRISHNA Cal/Val Overview – high resolution temperature variability

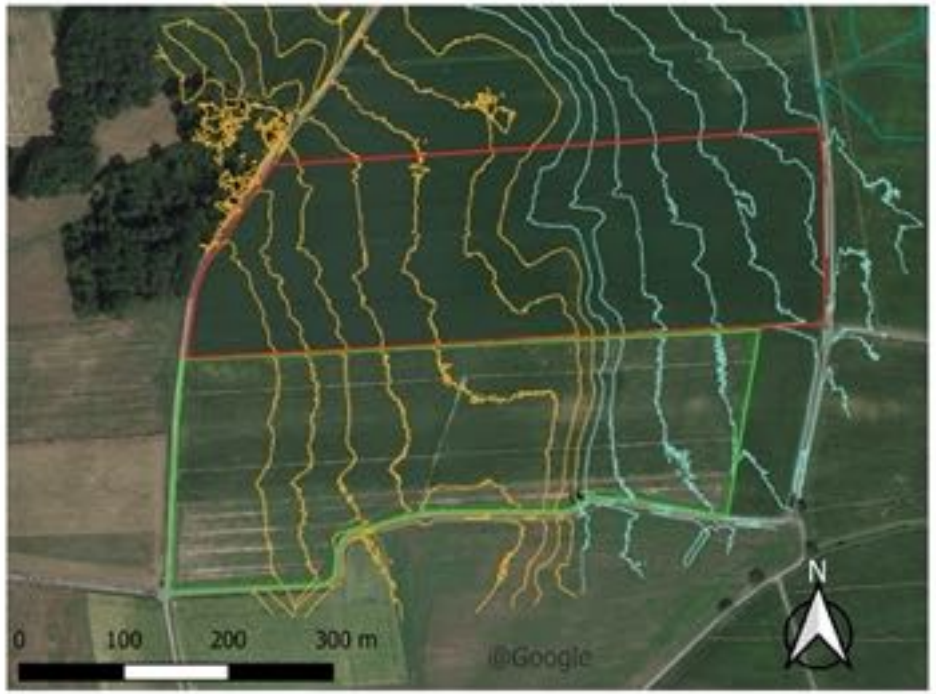
Analysis of of **agricultural practices**

- *Improve the interpretation of High resolution TIR images*

Example Estampes

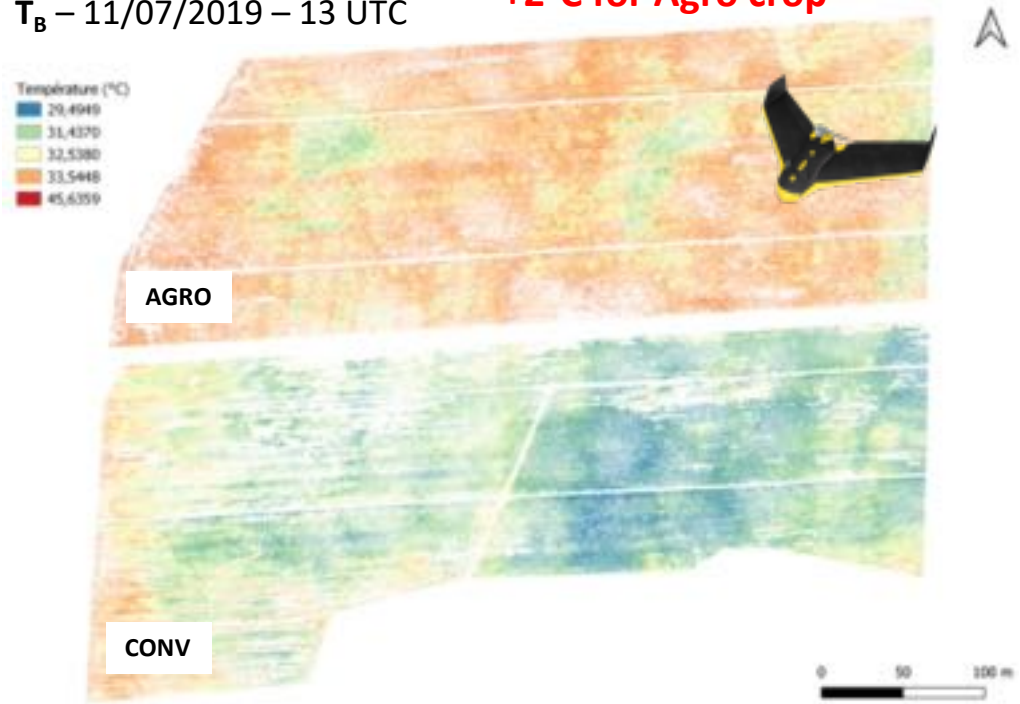


2 corn crops **same** LAI (~3,3m²/m²), **same** plant density
One Bio (Agro) & One traditional (Conv).



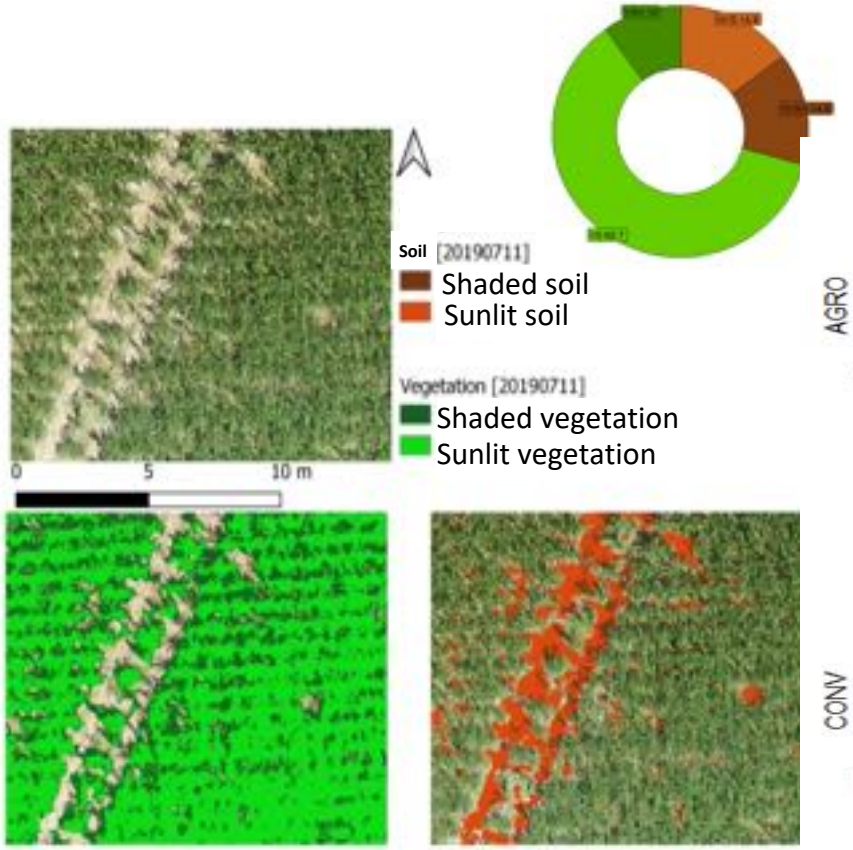
T_B – 11/07/2019 – 13 UTC

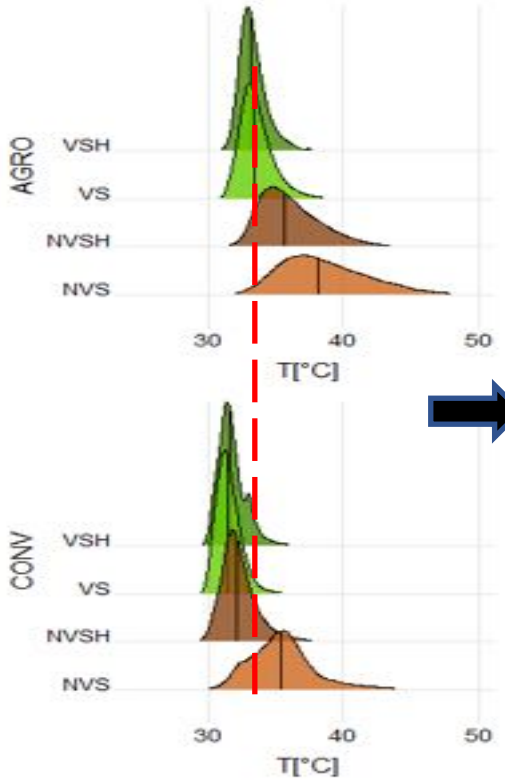
+2°C for Agro crop



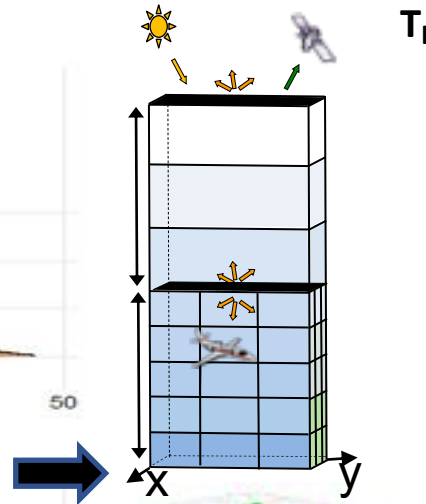
Difference related to water conditions, radiative budget ?

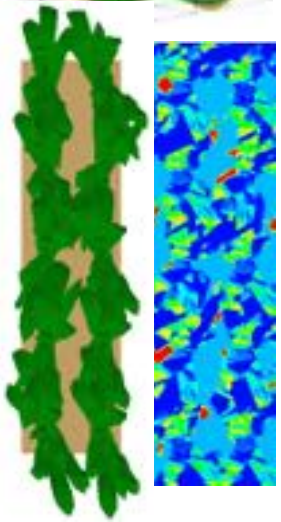
TRISHNA Cal/Val Overview – high resolution temperature variability



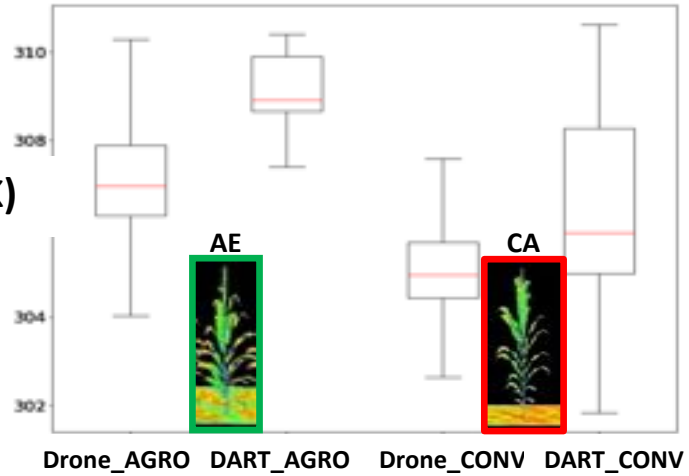


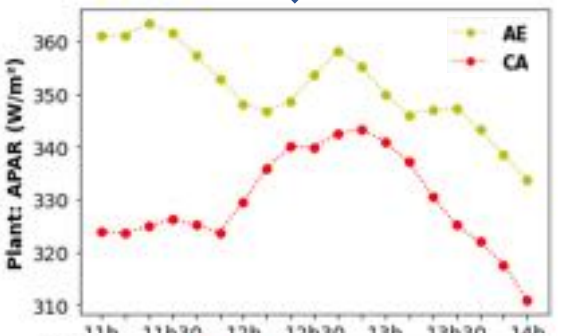
DART Model

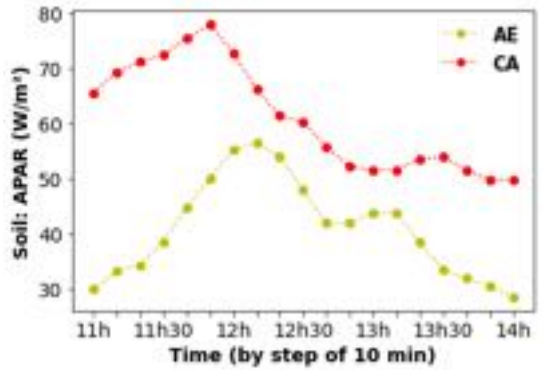




Thermal (DART vs. UAV obs.)







Classification→ temperature separation **sunlight/shaded**

TRISHNA Cal/Val Overview – Recent work - Urban

Presentation 131 and Poster 227

Reference urban data for LST, LSE and climate modeling
https://camcatt.sedoo.fr

On ground measurement (3 teams)

3 CIMEL: 5-6 bands
8,0-14.0 µm

SOC 410: 6 bands
0.9-12.0 µm

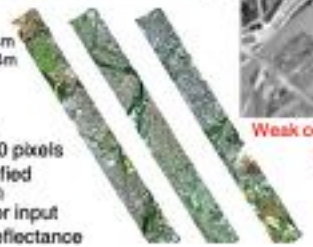
3 ASD: reflectance
0.4-2.5 µm

Day

Night

Weak contraste < 10K, cloudy

Fenix
Height 1524m
Swath: 1024m
GSD 1m
Level
Chunk of
5000*5000 pixels
Orthorectified
(BD ortho, IGN)
L at sensor input
Surface reflectance



Airborne data

LST, LSE estimation

- Collect optical properties from VIS to LWIR at ground level
- Airborne acquisitions

Exogen data

- Atmosphere characterization

Solene-Microclimat validation

- Instrumentation of a canyon

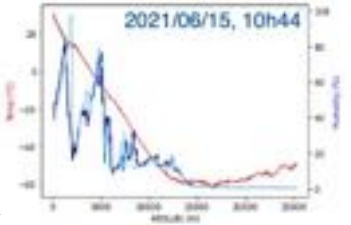
Calibration

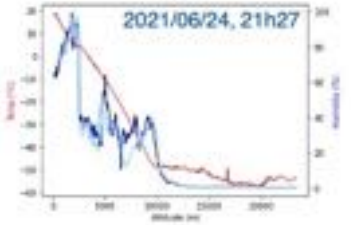
- Calibrate in flight the airborne cameras
- Intercalibrate on ground radiometers

From LST to Tair

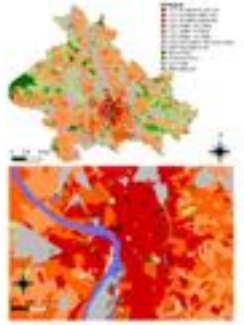
- Toulouse Meteostations network (Tair)
- Tair from vehicles moving in the city
- Airborne acquisitions

Radio soundings





Toulouse Métropole meteostations network (over 60)



LCZ Map (@CNRM)

Vehicles (Tair, Relative humidity)

2 transects... crossing different LCZ

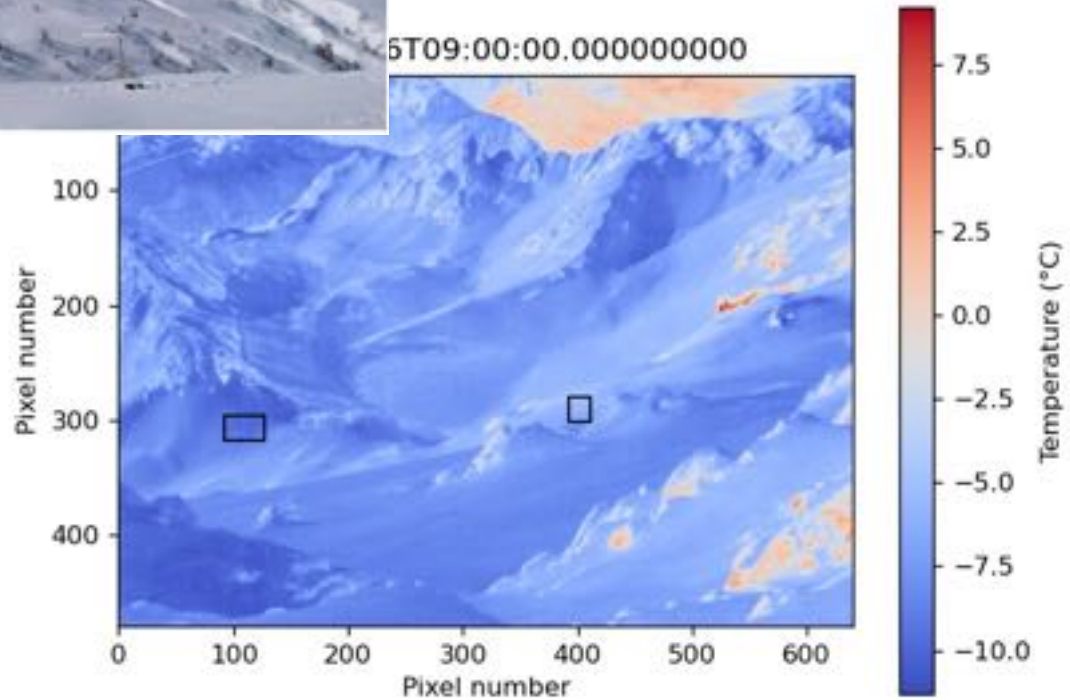
Long term measurements

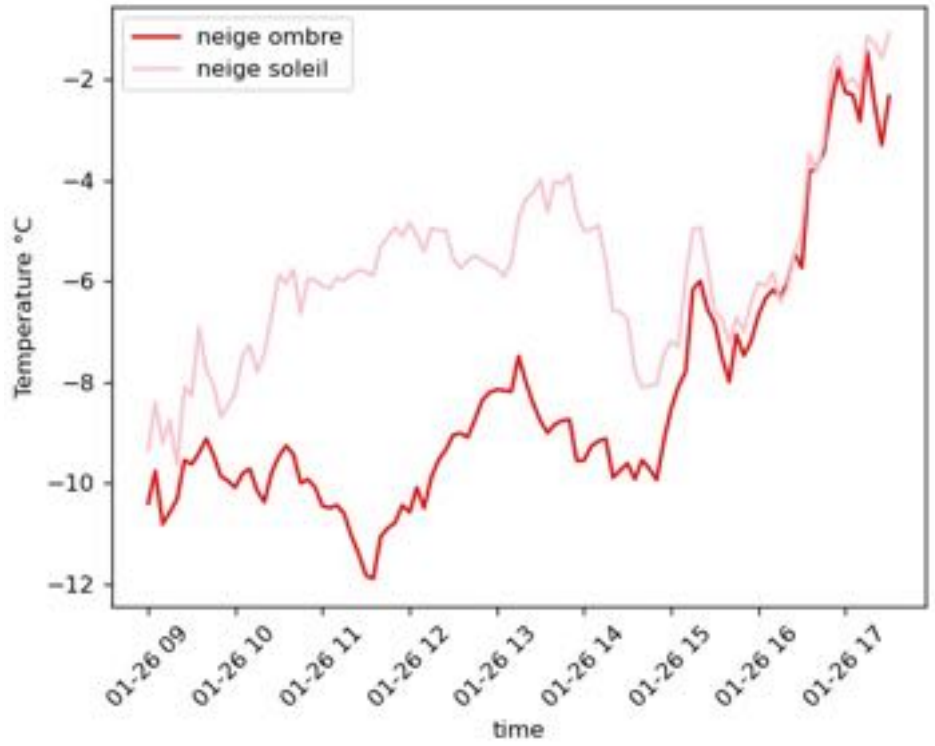
During flight

TRISHNA Cal/Val Overview – Recent work - Cryosphere

Presentation 205 and Poster 258

Site has been upgraded with Heitronics instruments

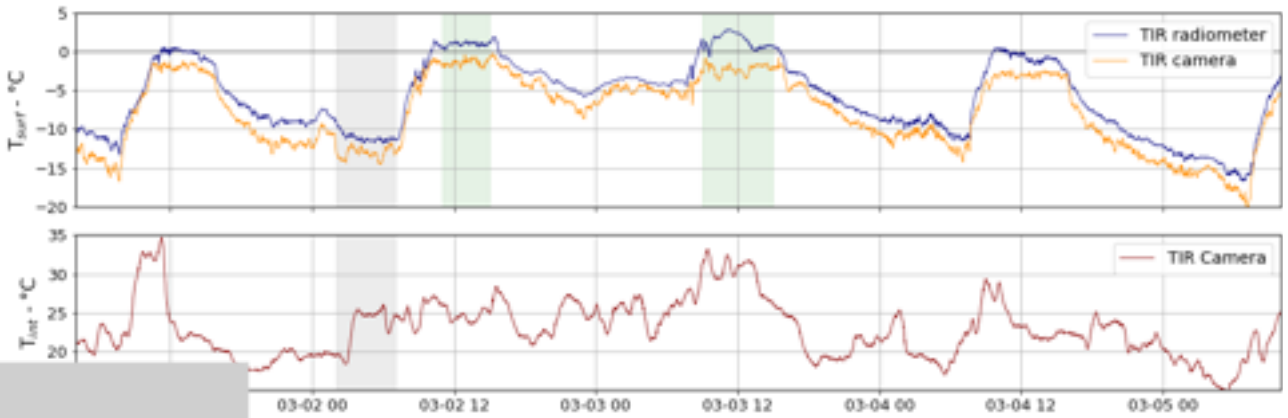


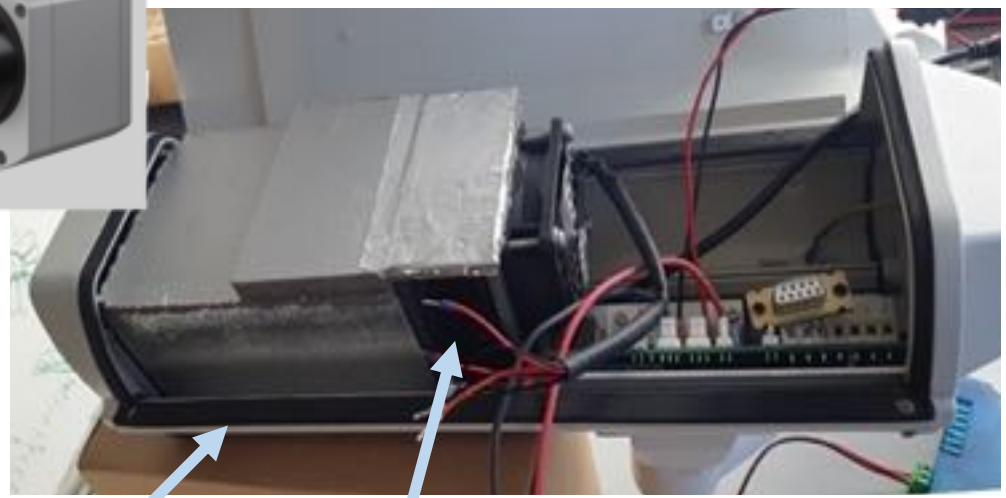


Shade/ Sun temperature of snow

Precise absolute temperature measurements are important to improve snow models

TRISHNA Cal/Val Overview – Recent work - Cryosphere

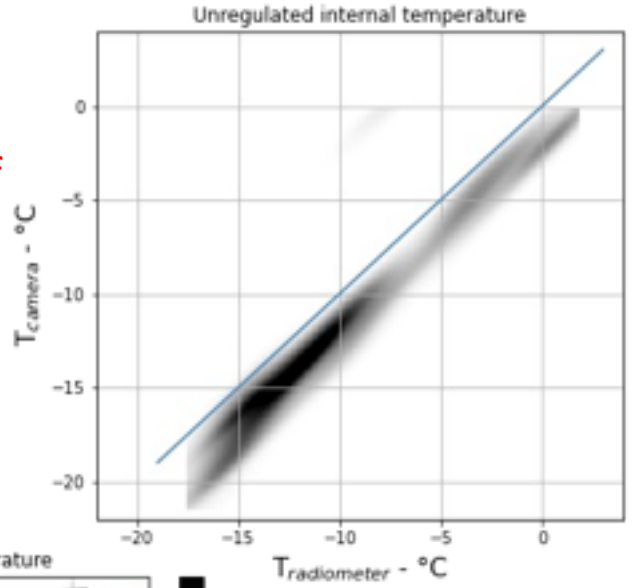


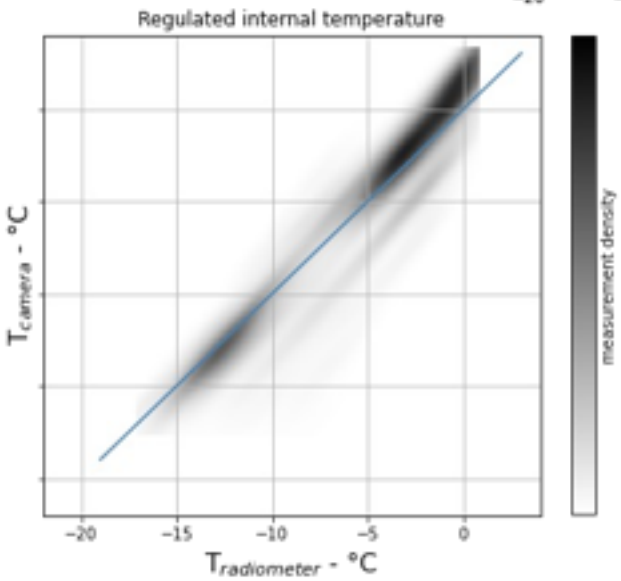


Insulated camera

Peltier unit

Standard Isolation of Optris PI TIR Camera





After **controlled internal temperature** of the Optris TIR Camera

Internal temperature **variations ~ 0.8°C**
for external temperatures **between -10°C - 15°C**

Potentiel for Cal/Val TIR Imaging

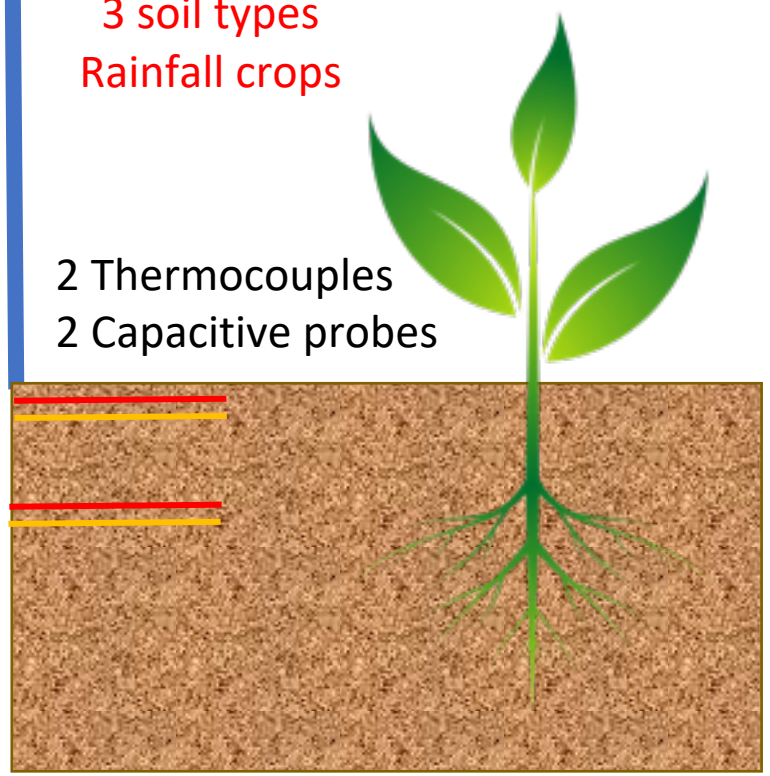
Some ongoing-future Cal/Val activities

TRISHNA Cal/Val Overview – On going and planned work – Ecosystem Stress

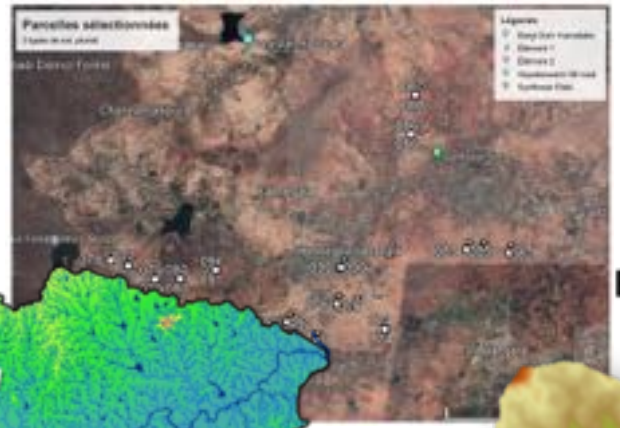
TIR camera

20 stations
3 soil types
Rainfall crops

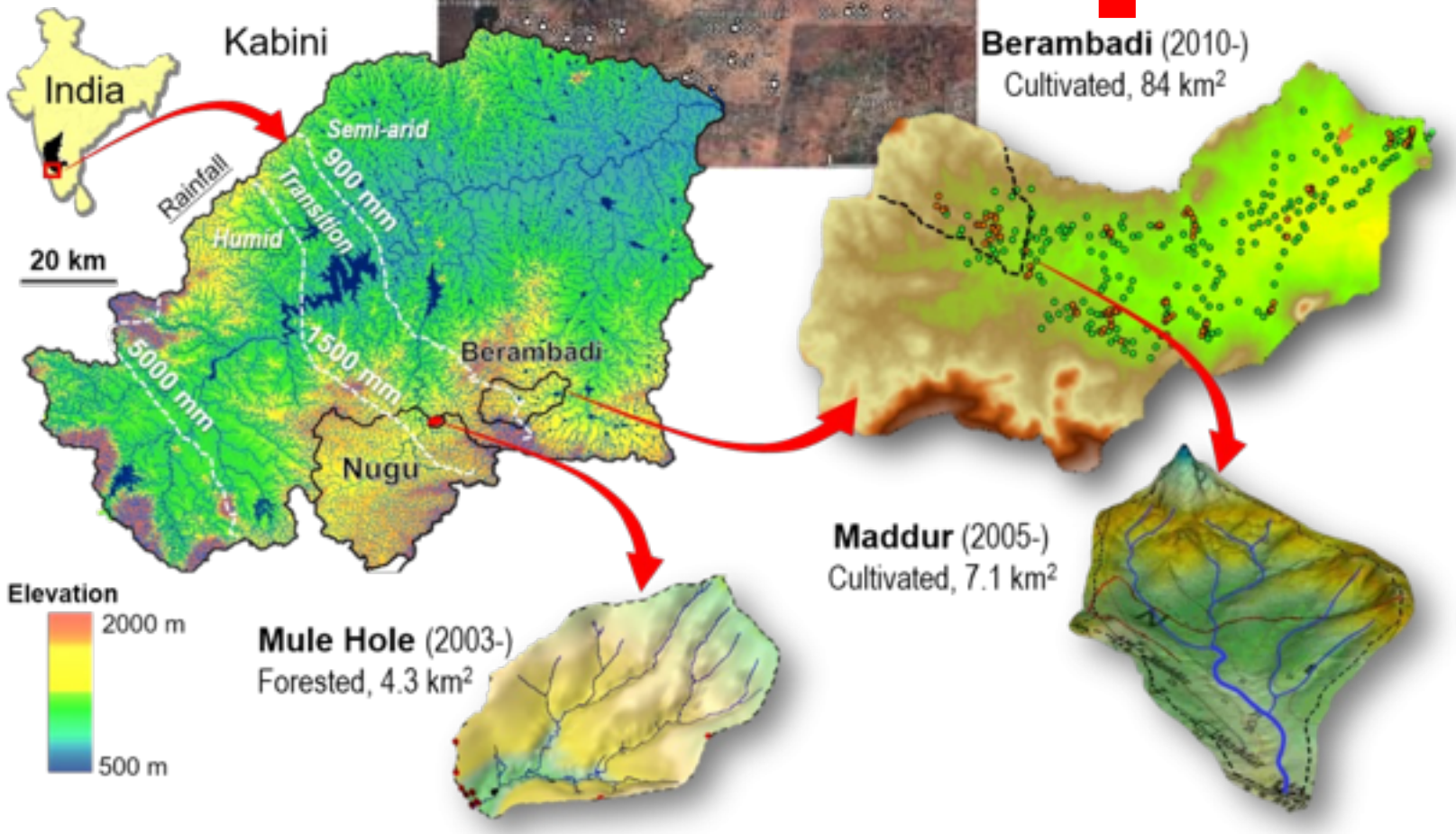
2 Thermocouples
2 Capacitive probes



M-TROPICS



Posters 191 & 201



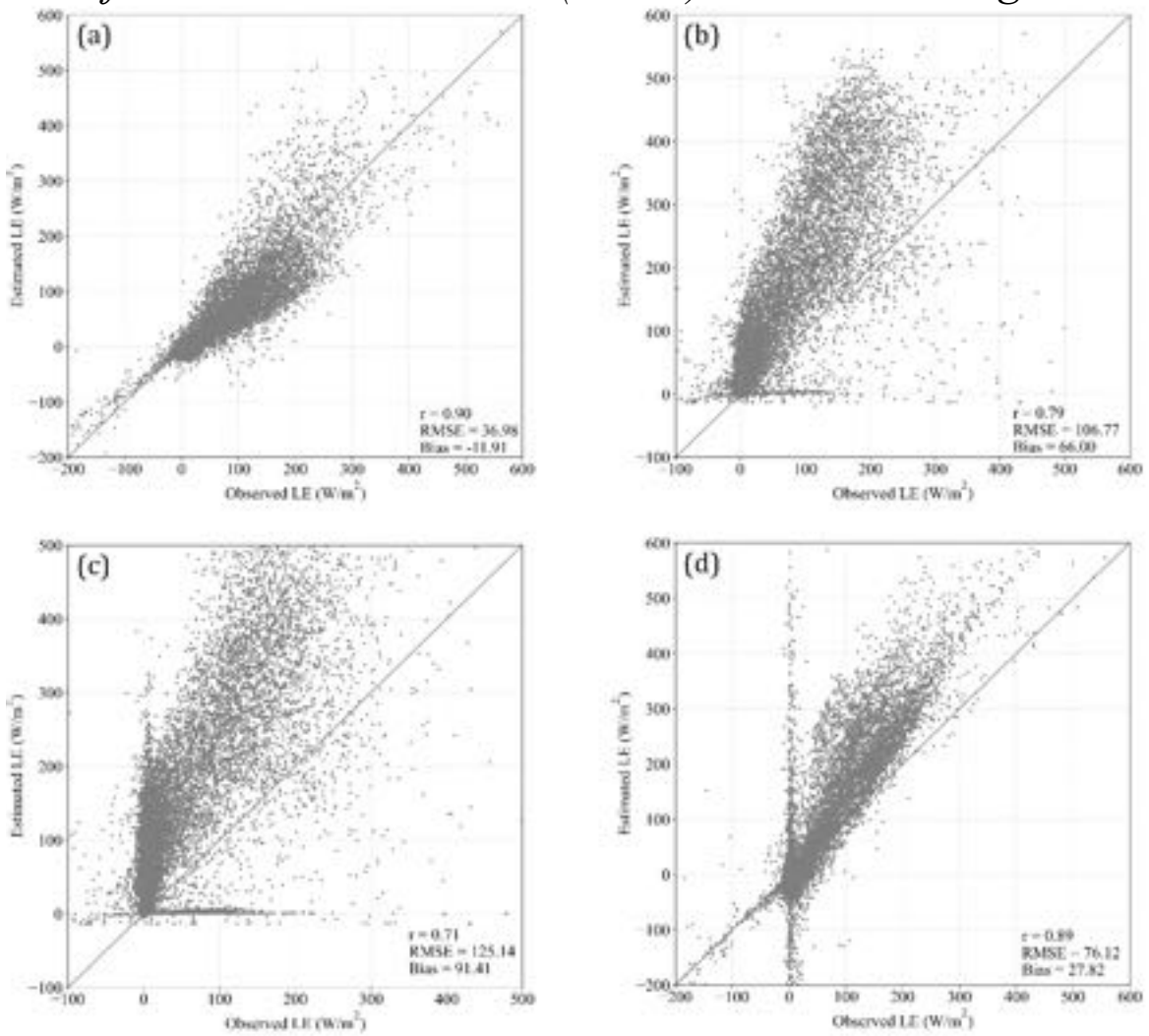
TRISHNA Cal/Val Overview – Ongoing and planned - Ecosystem Stress

Presentation 201 and Poster 191

Plots of observed vs estimated (model) LE at the Malegaon site.

PT-JPL

SPARSE Layer



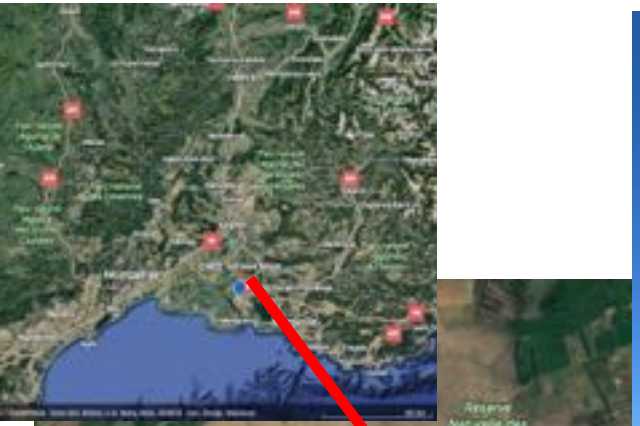
SPARSE Patch

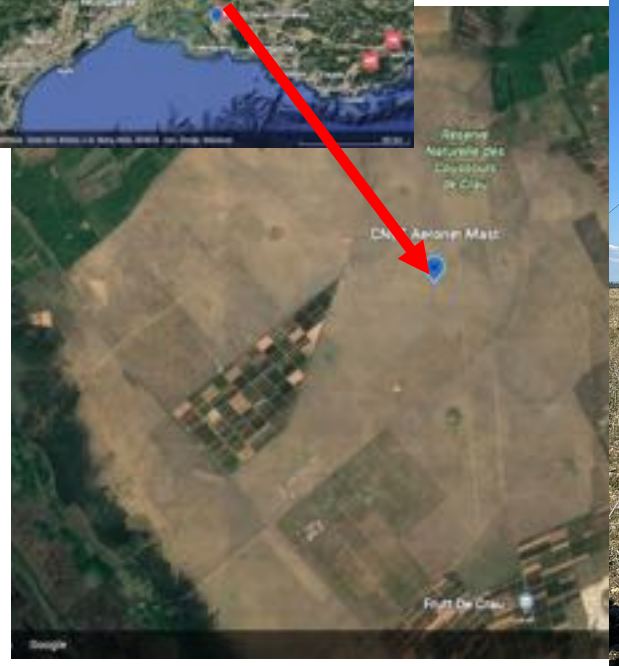
STIC

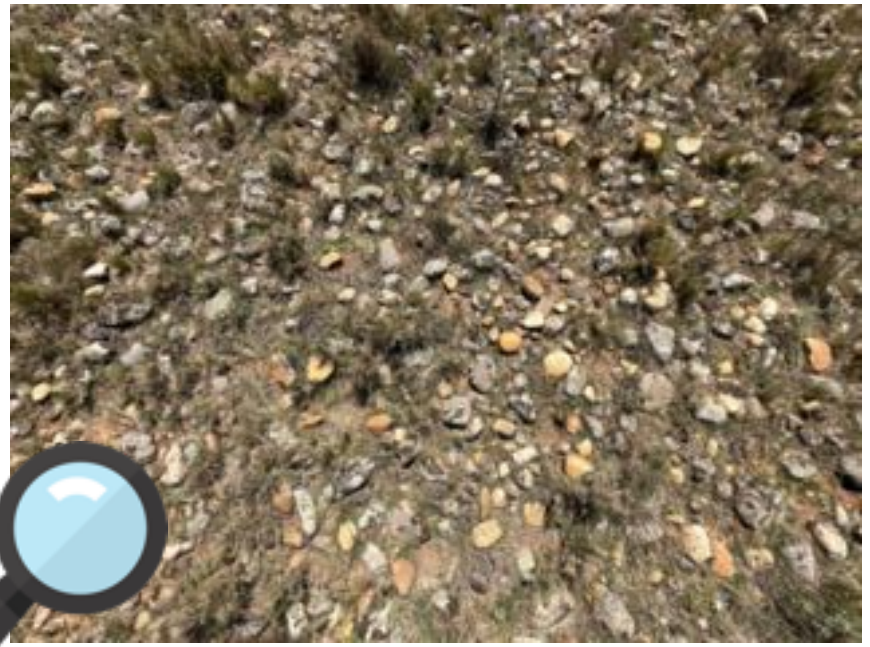
Results Athira, KV et al.

Evaporation validation in progress !

TRISHNA Cal/Val Overview – Ongoing and planned work – reference validation site at LaCrau





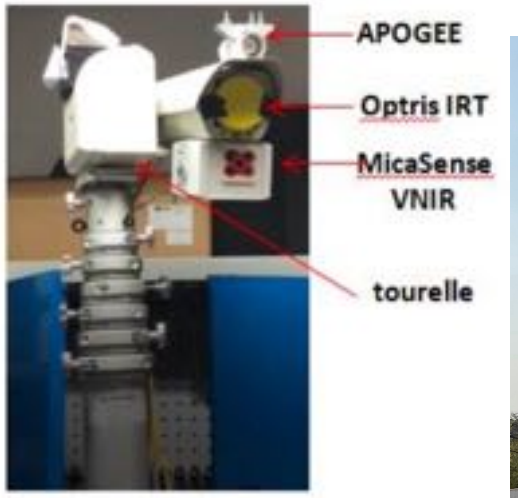


JPL radiometer (8-14µm) at LaCrau dedicated to long term TIR Cal/Val

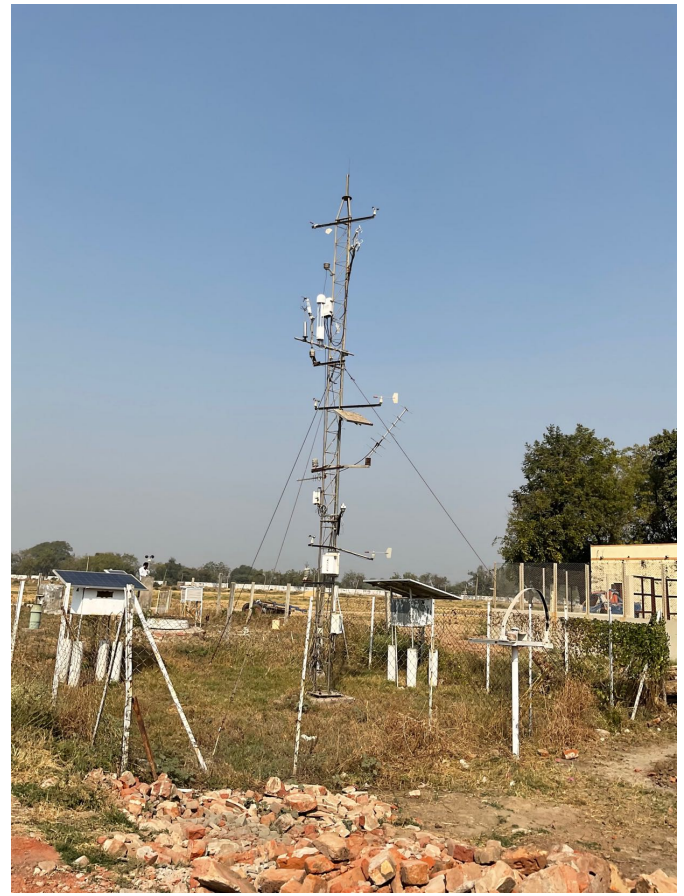
https://calval.jpl.nasa.gov/lacrau

CE312 + Evaluation of a multi spectral TIR radiometer (summer 2023)

TRISHNA Cal/Val Overview – Planned work – Directional validation sites



Reference Flux and met measurements on site



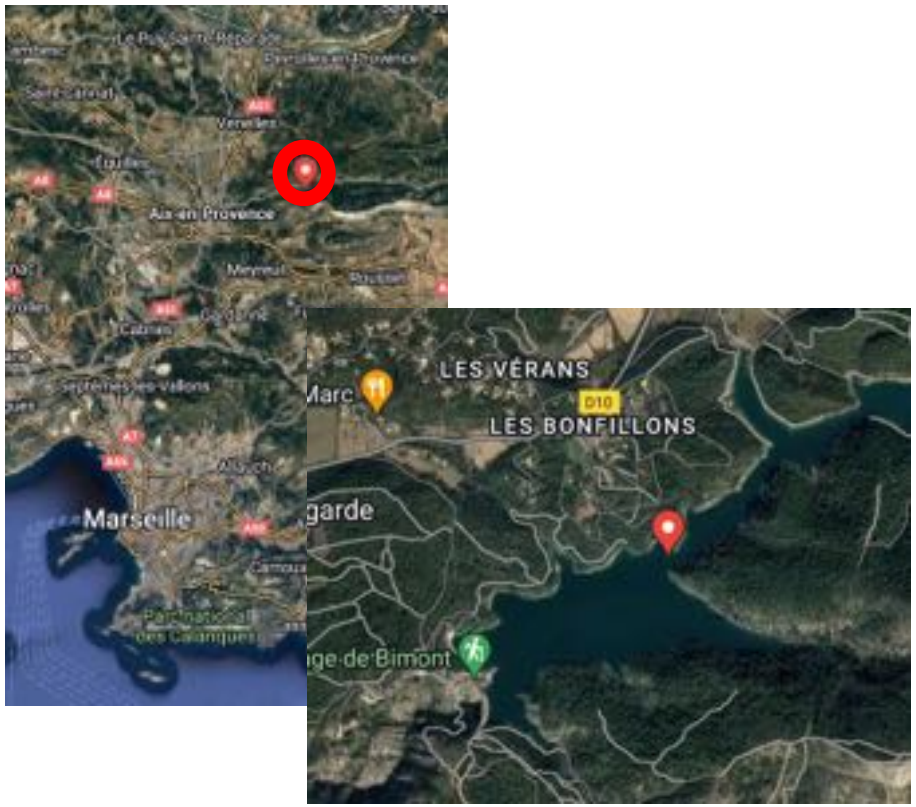
Directional **tracker** system to be installed at Nawagam site in India at the end of June

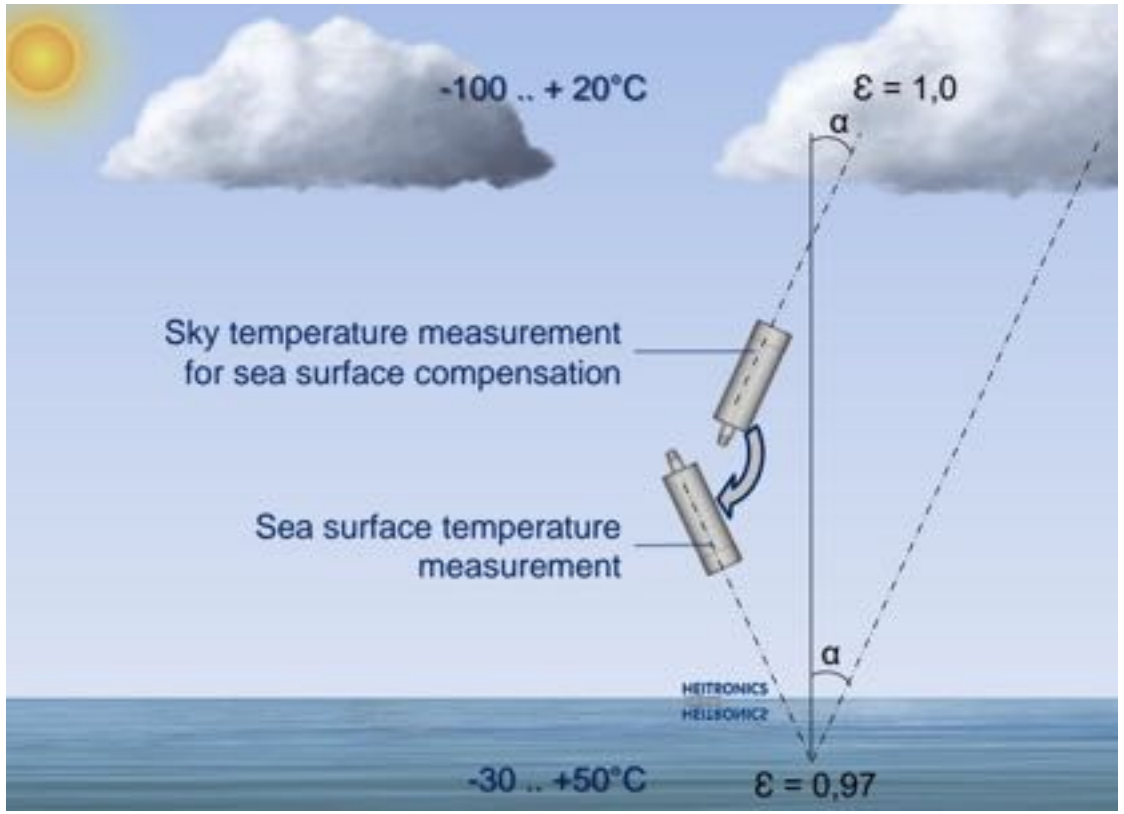
Directional and **turbulence** observations at daytime overpass to characterize both the Hot Spot and 'noise'

Product evaluation – LST - Evaporation

TRISHNA Cal/Val Overview – Planned work – Coastal and inland water bodies

Inland lake installation similar to lake Tahoe using Heitronics instruments
At Bimont lake site





Validation a water body site

TRISHNA Cal/Val Overview – Planned work – HyTES Campaign in France

Chosen sites

TRISHNA Cal/Val Overview – Planned work – HyTES Campaign in France

Name	Location	Science objectives	CAL/VAL Ground instr.	Institution	Networks
La Crau Pebbles, Grass	43°33’32.04N 4°51’51.84"E	Solar refl., TIR radiance, LST, BRDF, AOD, WVC	CIMEL photometer TIR radiometers	CNES	RadCalNet TIRCalNet
Puéchabon Forest, shrub, grassland	43.74°N 3.60°E	CO2 flux, LST, Energy balance	Flux tower (CEOS LPV supersite)	INRAE	ICOS FLUXNET
Banyuls Costal	42°29'18.7"N 3°08'34.6"E	Marine Observation	OPTRIS, UAV FLIR; Apogee, MicaSense, anemometer	CNRS	OOB
Toulouse Urban	43.6°N 1.4°E	Urban Heat Island			
Lamasquère Wheat	43°29’37.29N 1°14’8.51"E	BRDF VNIR, ET	CIMEL photometer, UAV FLIR	CESBIO	ICOS
Estampes Maize	43°23’36.43N 0°18’46.64"E	TIR Radiance, LST	OPTRIS, Apogee, Thermohygro buttons, UAV FLIR	CESBIO	
Bilos Pine forest	44°29’38.78N 0°57’21.70"W	TIR radiance, LST, ET	Sonics anemometer, KT5, UAV FLIR	INRAE	ICOS

HYTES campaign sites in France , sorted from East to West

- **Follow** and characterise our future category A *in situ* long term validation site for LST
  - Follow CEOS LPV LST protocols and improve where possible
- **Preparation** of the HyTES airborne campaign
- **Thematic** sites using **standardized** instrumentation and **protocols – multi-mission**
- Build on existing experience – ESA LAW Sites
- Integrate into existing network structures – ICOS ?
- Data harmonization and sharing **multi-mission**

TRISHNA Cal/Val Overview – Conclusions

- Aim to provide **quantifiable**, accurate LST validation observations for TRISHNA
- **Adapt** LPV protocols to the requirements of high resolution, high revisit TIR missions
- **Standardize** equipment, calibration, installation and validation protocols
- **Evaluate** our European based homogeneous land validation site
- In the multi-mission context develop **coordinated** validation efforts

TRISHNA Cal/Val Overview – **Thank You !**

Sara Arioli
Paul Boitard
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Jean-Pierre Lagouarde
Julien Michel
Laurent Poutier
Laure Roupioz
Thierry Tormos

Laurent Arnaud
Gilles Boulet
Emilie Delogu
Claire Marais-Scie
Françoise Nerry
Chadrikia Pinnepalli
Jean-Louis Roujean

Emmanuelle Autret
Xavier Briottet
Simon Gascoin
Sébastien Marcq
Ghislain Picard
Vincent Rivalland
José Sobrino

and many more !